WHAT IS CLAIMED IS:

1. An apparatus for guiding and positioning a machine component relative to a surface of a workpiece, the apparatus comprising:

first and second elongate flexible rails, the rails being spaced apart and approximately parallel to each other;

a plurality of vacuum attachment devices connected to each rail and spaced at intervals therealong for releasably attaching each rail to the surface of the workpiece by vacuum, with the widths of the rails extending substantially parallel to the surface of the workpiece, the rails bending and twisting as needed to substantially follow the surface of the workpiece; and

an X-axis carriage structured and arranged to support the machine component, the X-axis carriage slidably engaging the rails and being traversable along the rails so as to position the machine component relative to the workpiece.

2. The apparatus of claim 1, wherein each rail is relatively stiff in bending about a first bending axis and relatively flexible in bending about a second bending axis orthogonal to the first bending axis, and each rail is mounted on the workpiece such that the first bending axis is substantially normal to the workpiece surface and the second bending axis is substantially parallel to the workpiece surface.

3. The apparatus of claim 1, further comprising a connecting member connected between the rails at a location therealong to substantially fix a spacing distance between the rails at said location, the rails having freedom to move toward and away from each other at other locations remote from said location.

4. The apparatus of claim 1, wherein the attachment devices comprise vacuum cups.

5. The apparatus of claim 1, wherein the X-axis carriage is connected to the rails by flexible mounts.

6. The apparatus of claim 5, wherein the flexible mounts comprise plate-shaped springs.

7. The apparatus of claim 6, further comprising an X-axis drive device for driving the X-axis carriage along the rails, the X-axis drive device being mounted on one of the plate-shaped springs.

8. The apparatus of claim 7, wherein the X-axis drive device includes a drive member that engages a cooperating member on one of the rails.

9. The apparatus of claim 8, wherein the drive member extends through an aperture in the plate-shaped spring.

10. The apparatus of claim 1, wherein the X-axis carriage is slidably connected to the rails by rotary members that have a rolling engagement with the rails.

11. The apparatus of claim 10, wherein the rotary members are mounted on flexible mounts that are affixed to the X-axis carriage and can flex relative to the X-axis carriage to accommodate varying bending and twisting of the rails.

12. The apparatus of claim 1, further comprising a drill mounted on the X-axis carriage.

13. The apparatus of claim 12, further comprising an actuator connected to the X-axis carriage and a pressure foot coupled with the actuator, the actuator being operable to press the pressure foot against the workpiece surface generally normal thereto so as to exert a pre-load force between the workpiece and the X-axis carriage.

14. The apparatus of claim 13, wherein the pressure foot is connected with the drill such that a reaction force caused by drill thrust during drilling of the workpiece is reacted through the pressure foot so as to reduce the pre-load force between the pressure foot and the workpiece.

15. The apparatus of claim 14, wherein the drill is mounted on a Y-axis carriage that is slidable on the X-axis carriage along a Y axis, and wherein the actuator is connected between the Y-axis carriage and the drill.

16. The apparatus of claim 15, wherein the actuator comprises a plurality of fluid-operated cylinders.

17. An apparatus for drilling holes in a workpiece, comprising:

a pair of rails each of which is relatively flexible in bending about an axis extending in a direction across a width of each rail, and relatively stiff in bending about an axis extending in a thickness direction of each rail;

a plurality of attachment devices attached to each rail at spaced locations therealong for attaching the rails to a surface of the workpiece such that the thickness direction of each rail is substantially normal to the surface of the workpiece;

a carriage slidably mounted on the rails via a plurality of rail-engaging members connected to the carriage, the rail-engaging members being mounted on supports that are attached to the carriage, the supports and rail-engaging members being structured and arranged such that relative movement is permitted between the carriage and rails to accommodate varying bending and twisting of the rails; and

a drill supported on the carriage.

18. The apparatus of claim 17, wherein the supports comprise spring plates.

19. The apparatus of claim 18, wherein the rail-engaging members comprise rollers.

20. The apparatus of claim 17, wherein the supports comprise bearing cars that are attached to the carriage with spherical bearings.

21. The apparatus of claim 20, wherein the rail-engaging members comprise rollers.

22. The apparatus of claim 17, further comprising a drive motor mounted on one of the supports and in driving connection with a drive element that engages a cooperative driven element extending along one of the rails.

23. The apparatus of claim 22, wherein the drive element is a rotary gear element and the driven element is a linear gear element, the supports being resilient and supporting pairs of spaced rollers that receive each of the rails therebetween, the rotary gear element being arranged such that a rotational axis thereof is coplanar with rotational axes of one of the pairs of rollers mounted on the support that supports the drive motor.

24. A method of positioning a machine component relative to a compound-contoured surface of a workpiece such that a machine axis of the machine component is substantially normal to the surface of the workpiece, comprising:

slidably mounting a first carriage on a pair of spaced-apart flexible rails that are relatively flexible in bending about first bending axes and relatively inflexible in bending about second bending axes;

affixing the rails to the surface of the workpiece such that first bending axes are substantially parallel to the workpiece surface and the second bending axes are substantially normal to the workpiece surface, whereby the rails bend and twist as needed to substantially conform to the surface of the workpiece such that a reference axis of the first carriage at any position along the rails is substantially normal to the workpiece surface; and

fixing the machine component on the first carriage such that the machine axis of the machine component is aligned along the reference axis of the first carriage, whereby the machine axis is positioned substantially normal to the workpiece surface.

25. The method of claim 24, further comprising providing a second carriage mounted on the first carriage such that the second carriage is slidable on the first carriage along a direction defined by a Y axis parallel to the workpiece surface, the first carriage being slidable along the rails in a direction defined by an X axis perpendicular to the Y axis, and wherein the machine component is affixed to the second carriage.

26. The method of claim 25, further comprising determining a mathematical transformation of the compound-contoured workpiece surface into a two-dimensional flat pattern, and controlling positioning of the first and second carriages based on the flat pattern.

27. A method of positioning a drill for drilling a workpiece having a contoured surface such that drilling occurs along an axis that is substantially normal to the workpiece surface at any point thereon, the method comprising:

transforming a mathematical three-dimensional representation of the workpiece surface into a two-dimensional flat pattern such that each point $(x, y, z)$ on the workpiece surface is transformed into a corresponding point $(X, Y)$ on the flat pattern;

positioning the drill along the workpiece surface so that drilling will occur at a desired point $(x_1, y_1, z_1)$ by positioning the drill to intersect a point $(X_1, Y_1)$ on the flat pattern corresponding to the point $(x_1, y_1, z_1)$; and

orienting the drill with a drilling axis thereof substantially normal to the workpiece surface at the point $(x_1, y_1, z_1)$ by mounting the drill on a support system that is attached to the workpiece surface and automatically orients the drilling axis substantially normal to the workpiece surface.

28. The method of claim 27, wherein the step of orienting the drill comprises attaching a pair of spaced flexible rails to the workpiece surface such that the rails bend and twist as needed to follow the contour of the workpiece surface, with the rails approximately parallel to each other, and slidably mounting the drill on the rails, the rails positioning the drill such that the drilling axis is substantially normal to the workpiece surface at any position of the drill along the rails.